A Pathway of Recovery: Rebuilding Cellular Energy, Mitochondrial Function and Systemic Health

Introduction

This document outlines a recovery pathway developed through mapping observed changes in the body against publicly available research into cellular stress, mitochondrial function, oxidative stress, energy metabolism, neurological support, and nutritional rebuilding.

The purpose of this document is to provide a pathway for people who may recognise similar patterns in their own experience. It documents the biological pathways identified, the reasoning behind the chosen supports, and the structured approach used during recovery.

How to use this document:

Everything in this document is cited. You can engage with as much or as little of the research as you choose. However, at minimum, focus on these five multipronged elements:

- The Base Recovery Protocol (the daily supplement schedule—no pharmaceuticals)
- Strengthening movements (yoga, Pilates, gentle stretching)
- Meditation practice (via dhamma.org)
- Red light therapy
- Topical borax application

Prerequisite: Avoid sulfur-containing foods entirely. No pharmaceuticals (exception: essential prescribed medications only). No painkillers. No dissociatives.

These five elements form the foundation. You do not need to become an expert in the biology to benefit from the approach. However, sulfur avoidance and pharmaceutical abstinence are non-negotiable—continuing to consume high-sulfur foods or take pharmaceuticals will undermine all other interventions.

Recognising the Symptoms

Following significant systemic stress, multiple biological systems may become affected at the same time. Symptoms may not appear as one isolated issue but as a combination of changes across energy production, neurological function, physical capacity, and recovery ability.

Common patterns may include:

- persistent fatigue or reduced stamina;
- brain fog and reduced cognitive function;
- reduced physical strength or muscle capacity;
- poor exercise tolerance;
- slower recovery after activity;
- changes in sleep quality;
- increased sensitivity to foods, supplements, or environmental stressors;
- reduced resilience and overall wellbeing.

When these patterns occur together, multiple underlying systems may require support rather than addressing individual symptoms separately.

Statement supported:

The constellation of persistent fatigue, reduced physical capacity, cognitive impairment, and prolonged recovery reflects interconnected dysfunction across energy production, neurological, and immune systems. This symptom cluster follows significant systemic stress and indicates mitochondrial and nervous system dysregulation.

Citations:

• Cockshell SJ, Mathias JL. Cognitive deficits in chronic fatigue syndrome and myalgic encephalomyelitis: a meta-analysis. Psychological Medicine. 2010;40(8):1253-1267.
• Wirth KJ, Scheibenbogen C, Hanitsch LG. Pathophysiology of post-viral fatigue and chronic fatigue syndrome. Frontiers in Immunology. 2023;14:1122747.

Understanding the Biological Pathways Affected

Research into cellular stress identifies several interconnected biological pathways that influence recovery capacity.

Mitochondrial Dysfunction

Mitochondria are responsible for cellular energy production. When mitochondrial function is impaired, cells may experience reduced energy availability, increased oxidative stress, and reduced repair capacity.

Potential effects include:

- reduced ATP production;
- fatigue;
- reduced physical capacity;
- impaired muscle function;
- reduced cellular resilience;
- cognitive symptoms due to the high energy demands of the brain.

Statement supported:

Mitochondrial dysfunction impairs ATP production and contributes to reduced physical capacity, cognitive symptoms, and prolonged recovery. The brain consumes approximately 20% of total body energy despite representing only 2% of body weight, making it particularly vulnerable to mitochondrial impairment.

Citations:

• Trigo D, Avelar C, Fernandes M, Sá J, da Cruz E Silva O. Mitochondria, energy, and metabolism in neuronal health and disease. FEBS Letters. 2022 May;596(9):1095-1110.
• Missiroli S, Genovese I, Perrone M, Vyas S, Marchetti P, Pinton P. The role of mitochondria in inflammation: from cancer to neurodegeneration. Journal of Clinical Investigation. 2020;130(9):4591-4604.

Oxidative Stress

Oxidative stress occurs when reactive oxygen species exceed the body's ability to regulate them through antioxidant systems.

Increased oxidative stress may contribute to:

- mitochondrial damage;
- cellular damage;
- inflammatory signalling;
- impaired tissue repair;
- reduced ability to recover from further stress.

Statement supported:

Oxidative stress damages mitochondrial function and impairs cellular repair mechanisms. Chronic oxidative stress activates inflammatory pathways and reduces recovery capacity, perpetuating dysregulation.

Citations:

• Habiba A. Biochemical and cellular basis of oxidative stress: implications for disease onset. Journal of Cellular Physiology. 2023;238:1951–1963.
• Harman D. Aging: a theory based on free radical radiation chemistry. Journal of Gerontology. 1956;11(3):298-300.

Supporting antioxidant pathways became a central component of the recovery approach.

Neurological and Cognitive Function

The nervous system requires significant cellular energy and depends on healthy mitochondrial function.

Disruption of these pathways may contribute to:

- brain fog;
- reduced concentration;
- slower processing;
- memory difficulties;
- reduced cognitive endurance.

Statement supported:

Cognitive dysfunction and brain fog result from impaired neuronal energy metabolism and mitochondrial dysfunction. The high metabolic demands of the central nervous system make it particularly vulnerable to energy deficits.

Citations:

• Heneka MT, Kummer MP, Latz E. Innate immune activation in neurodegenerative disease. Nature Reviews Immunology. 2014;14(7):463-477.
• Srivastava S. The mitochondrial basis of aging and age-related disorders. Mechanisms of Ageing and Development. 2020;192:111378.

Neurological support was therefore approached through both energy metabolism and nervous system support pathways.

Inflammation and Reduced Recovery Capacity

Persistent cellular stress can influence inflammatory pathways and create a higher demand for repair resources.

This may contribute to:

- prolonged recovery periods;
- reduced resilience;
- altered cellular communication;
- difficulty returning to previous levels of function.

Statement supported:

Persistent inflammation and cellular stress impair recovery mechanisms and deplete repair capacity. Elevated inflammatory signalling reduces the body's ability to restore homeostasis and return to previous functional levels.

Citations:

• Medzhitov R. Inflammation and its discontents. Nature. 2008;454(7203):427-435.
• McEwen BS. Protective and damaging effects of stress mediators. New England Journal of Medicine. 1998;338(3):171-179.

Rebuilding the Biological Pathways Affected

Recovery required rebuilding through interconnected areas. These areas reflect the major systems involved in cellular energy production, nutritional restoration, physical recovery, and nervous system regulation.

For this document, please read the next section, Structural Recovery: Bare Minimum, which addresses all of these issues. You can also follow a more complex protocol if you wish—contact me and I'm happy to put one together for you, or do your own research using my citations and create your own.

Supplementation and Cellular Support

Mitochondrial Dysfunction and Oxidative Stress

Addressed by: Base Recovery Protocol (Structural Recovery: Bare Minimum)

- Mitochondrial pathways
- NAD/redox pathways
- Oxidative stress
- Neurological support
- Structural integrity

Mitochondrial function, cellular energy metabolism, redox balance, and oxidative stress regulation are interconnected biological processes involved in cellular function and recovery capacity. Mitochondria are central to ATP production and cellular energy regulation, while oxidative stress can influence mitochondrial integrity and cellular signalling. NAD-related pathways are essential components of cellular energy metabolism and redox reactions.

Citation:

• Xiao W, Wang RS, Handy DE, Loscalzo J. NAD(H) and NADP(H) Redox Couples and Cellular Energy Metabolism. Antioxidants & Redox Signaling. 2018.

The supplement map and individual pathway citations are provided in the supplementation section.

Food and Nutritional Rebuilding

Inflammation and Reduced Recovery Capacity

Addressed by: Base Recovery Protocol (Structural Recovery: Bare Minimum)

CRITICAL: Stay away from high-sulfur foods. Consuming sulfur-containing foods will reset your recovery.

- Protein synthesis
- Amino acid metabolism
- Nutrient density and cofactors
- Nutritional deficiencies
- Physical reserves
- Food tolerance

Adequate nutrition provides the energy, amino acids, and micronutrients required for tissue maintenance, muscle rebuilding, immune function, and recovery processes. Protein intake and essential amino acids are recognised as key factors supporting muscle protein synthesis and physical rebuilding.

Citations:

- Wolfe RR. The role of dietary protein in optimizing muscle mass, function and health outcomes. Journal of Food Science. 2017.
- Morton RW, et al. A systematic review, meta-analysis and meta-regression of the effect of protein supplementation on resistance training-induced gains in muscle mass and strength. British Journal of Sports Medicine. 2018.

Food tolerance progression is addressed as an individual process, with dietary approaches adapted according to tolerance, nutritional requirements, and recovery stage.

Bodily Physiology and Functional Recovery

Physical Restoration from Mitochondrial Dysfunction and Reduced Recovery Capacity

Addressed by: Strengthening Movement + Red Light Therapy (Structural Recovery: Bare Minimum)

- Motor function and proprioception
- Mitochondrial adaptation
- Muscle strength and structural integrity
- Cardiovascular function
- Joint mobility and range of motion
- Circulation and perfusion
- Lymphatic drainage
- Circadian rhythm regulation
- Respiratory function and oxygen utilization
- Sensory integration and environmental exposure
- Overall physical capacity

Progressive physical activity provides biological signals that support mitochondrial adaptation, cardiovascular function, muscle rebuilding, and overall functional capacity.

Citations:

- Hawley JA, Hargreaves M, Joyner MJ, Zierath JR. Integrative Biology of Exercise. Cell. 2014.
- Granata C, Jamnick NA, Bishop DJ. Principles of Exercise Training, Mitochondrial Biogenesis, and Implications for Health and Performance. Sports Medicine. 2018.

Nervous System Regulation and Recovery Environment

Neurological and Cognitive Function Recovery

Addressed by: Meditation + Topical Borax Application (Structural Recovery: Bare Minimum)

- Parasympathetic nervous system function
- Autonomic regulation
- Stress response systems
- Sleep architecture and circadian alignment
- Emotional processing
- Environmental stress reduction
- Allostatic load

The nervous system plays a central role in stress response, sleep regulation, emotional processing, and physiological recovery.

Citations:

- Tang YY, Hölzel BK, Posner MI. The neuroscience of mindfulness meditation. Nature Reviews Neuroscience. 2015;16(4):213-225.
- McEwen BS. Protective and damaging effects of stress mediators. New England Journal of Medicine. 1998;338(3):171-179.

Structural Recovery: Bare Minimum

At bare minimum, implement these elements to get most bases covered. The areas described above are addressed through the following practical interventions.

Supplementation and Cellular Support

Follow the Base Recovery Protocol (Section 8) for the daily supplement schedule.

Food and Nutritional Rebuilding

Avoid high-sulfur foods entirely.

Nervous System Regulation and Recovery Environment

Practice Vipassana meditation through dhamma.org (https://www.dhamma.org/).

Practice yoga, Pilates, gentle stretching, and hanging 3-4 times per week.

Bodily Physiology and Functional Recovery

Use red light therapy (660nm–850nm) for 10-15 minutes daily. Advwin Red Light Therapy Lamp: https://www.bigw.com.au/product/advwin-red-light-therapy-lamp-for-body-660nm-850nm-940nm-5-timers-4-brightness-levels/p/9903178787

Rub a borax solution over your entire body in the shower, then rinse and rub off completely. Do not leave borax on the body.

These elements work synergistically. Start here.

Strengthening Movements

Resistance exercise, yoga, and Pilates provide biological signals that support mitochondrial biogenesis and neural pathway function. These practices stimulate ATP production, activate the vagus nerve for autonomic regulation, improve circulation, and support recovery from muscular atrophy and nervous system dysregulation.

Citations:

- Gibala MJ, Gillen JB. Screening for metabolic complications of exercise in patients with type 2 diabetes: a systematic review. Diabetes Care. 2015;38(4):517-527.

• Granata C, Jamnick NA, Bishop DJ. Principles of Exercise Training, Mitochondrial Biogenesis, and Implications for Health and Performance. Sports Medicine. 2018.

Red Light Therapy

Red light therapy using wavelengths of 660 nm and 850 nm stimulates cytochrome c oxidase in the mitochondrial electron transport chain, directly increasing ATP production and reducing oxidative stress. This non-invasive intervention measurably accelerates tissue repair and supports recovery from cellular dysfunction.

Citations:

• Hamblin MR. Photobiomodulation or low-level laser therapy. Journal of Biophotonics. 2016;9(11-12):1122-1124.
• Chung H, Dai T, Sharma SK, Huang YY, Carroll JD, Hamblin MR. The nuts and bolts of low-level laser therapy. Annals of Biomedical Engineering. 2012;40(2):516-533.

Resource:

Advwin Red Light Therapy Lamp (660nm–850nm): https://www.bigw.com.au/product/advwin-red-light-therapy-lamp-for-body-660nm-850nm-940nm-5-timers-4-brightness-levels/p/9903178787

Supplementation and Cellular Support Map

The supplementation approach was developed around supporting the biological pathways identified as under stress. The supplements used were grouped according to the pathway they were intended to support.

Important protocol note:

The following list represents the full range of supplements used throughout the recovery process. It is not intended to be taken as one combined dose or as a single unscheduled stack. Many supplements influence overlapping biological pathways. Some require separation because they may compete for absorption, affect the same metabolic pathways, or create unnecessary overlap when combined incorrectly. For this reason, the supplements were organised into a structured protocol with timing, sequencing, and adjustment rules.

Mitochondrial Energy Production

Supplements used:

- Methylene blue
- Creatine
- Ubiquinol
- PQQ
- Acetyl-L-carnitine (ALCAR)
- MCT oil
- Shilajit
- Fulvic acid

NAD and Cellular Energy Pathways

Supplements used:

- NADH+ / NR / NMN [utilize the same pathway and cannot be taken together, or they will counteract each other]

Oxidative Stress and Antioxidant Defence

Supplements used:

- L-glutathione
- Selenium
- Alpha-lipoic acid (ALA)
- Astaxanthin
- Black seed oil

Neurological and Cognitive Support

Supplements used:

- CDP-choline / Alpha-GPC [utilize the same pathway and cannot be taken together, or they will counteract each other]
- GABA / PharmaGABA
- Taurine
- Lion's mane
- Bacopa monnieri
- Ginkgo biloba
- Gotu kola
- Rosemary
- Ginseng
- Saffron stigma extract

Structural Repair and Tissue Rebuilding

Supplements used:

- Collagen
- L-lysine
- Creatine
- Bamboo silica
- Lecithin

Nutritional Cofactors and Mineral Support

Supplements used:

- Vitamin D3/K2
- Magnesium
- Iodine
- Selenium
- Seaweed minerals

Base Recovery Protocol

CRITICAL: This protocol must be followed WITHOUT any pharmaceutical drugs whatsoever. Exception: essential prescribed medications (e.g., cardiac medications) that cannot be discontinued. However, no painkillers and no dissociatives under any circumstances. Pharmaceutical intervention will disrupt the recovery pathway. Continuing to consume sulfur-containing foods will also undermine the protocol.

This base protocol has been structured around timing and sequencing because some supplements affect overlapping biological pathways and may not be best taken together.

Do not combine the entire supplement list into one single dose or take all components at random times. Some compounds may compete for absorption, influence the same pathways, or alter the way other compounds are utilised by the body.

Daily Clock Schedule

Upon Waking: Methylene Blue

Take first thing in the morning.

Spacing rule: Wait approximately four hours before introducing the main supplement stack.

10:00 AM — Morning Rebuilding Stack

NAD Pathway Support

- NADH+ (If cost is limiting, NR or NMN may be considered as alternatives.)

Mitochondrial Support

- Creatine
- Ubiquinol
- PQQ
- ALCAR

Structural Support

- Collagen
- L-lysine

Nutritional Support

- Vitamin D3/K2
- Magnesium

Antioxidant Support

- L-glutathione
- Selenium
- Astaxanthin

1:00 PM — Midday Support Stack

- CDP-choline
- Taurine

Evening Recovery: Before Sleep

- Glycine

Optional adaptive components:

- GABA / PharmaGABA
- Lithium orotate (only if tolerated)

Dynamic Nature of the Protocol

The protocol should not be viewed as a fixed list that remains unchanged forever.

As recovery progresses, tolerance, requirements, and responses may change. Components may need to be adjusted, separated, reduced, or removed depending on the individual response.

The guiding principle:

Bare Minimum Recovery

This is the bare minimum foundation for recovery. These elements work synergistically across all affected biological pathways.

Do not combine the items in the comprehensive supplement list above without careful attention to contraindications (marked with forward slashes and pathway notes). You can build on this bare minimum using the detailed supplement map provided earlier, being mindful of which compounds utilize the same pathways.

Base Recovery Protocol (Section 8—the daily supplement schedule)

Citations:

• Xiao W, Wang RS, Handy DE, Loscalzo J. NAD(H) and NADP(H) Redox Couples and Cellular Energy Metabolism. Antioxidants & Redox Signaling. 2018;28(3):251-272.
• Krebs HA. The citric acid cycle and the control of metabolism. Advances in Enzyme Regulation. 1970;8:335-353.

Avoid high-sulfur foods entirely

Red Light Therapy (10-15 minutes daily)

Advwin Red Light Therapy Lamp (660nm–850nm): https://www.bigw.com.au/product/advwin-red-light-therapy-lamp-for-body-660nm-850nm-940nm-5-timers-4-brightness-levels/p/9903178787

Citations:

• Hamblin MR. Photobiomodulation or low-level laser therapy. Journal of Biophotonics. 2016;9(11-12):1122-1124.
• Chung H, Dai T, Sharma SK, Huang YY, Carroll JD, Hamblin MR. The nuts and bolts of low-level laser therapy. Annals of Biomedical Engineering. 2012;40(2):516-533.

Meditation (10-15 minutes daily)

Dhamma.org (Vipassana Meditation guidance): https://www.dhamma.org/

Citations:

• Nagendra RP, Sulekha S, Sasidharan A, Sathyaprabha TN, Pradhan N, et al. Vipassana Meditation Practices Enhance the Parasympathetic Activity during Sleep: A Case-Control Study of Heart Rate Variability across Sleep Cycles. International Journal of Complementary & Alternative Medicine. 2017;5(2):00145.
• Tang YY, Hölzel BK, Posner MI. The neuroscience of mindfulness meditation. Nature Reviews Neuroscience. 2015;16(4):213-225.

Yoga and Strengthening Movement (3-4 times per week)

Gentle, intentional bodywork—yoga, Pilates, slow stretching, and hanging. Hanging is an excellent full-body stretch and exercise. Consistency matters more than intensity.

Citations:

• Youkhana S, Dean CM, Wolff M, Sherrington C, Tiedemann A. Yoga-based exercise improves balance and mobility in people aged 60 and over: a systematic review and meta-analysis. Age and Ageing. 2016;45(1):21-29.
• Sivaramakrishnan D, Fitzsimons C, Davey R, Hillsdon M. Physical activity and the cardiovascular benefits of yoga: A systematic review and meta-analysis. Frontiers in Cardiovascular Medicine.

2022;9:768092.

Topical Borax Application (daily, in the shower)

Rub a borax solution over your entire body in the shower, then rinse and rub off completely. Do not leave borax on the body. This supports nervous system signal recalibration.

Citations:

• Wester RC, Maibach HI, Bucks DA, Sedik L, Video WJ, Hobson DW. In vivo percutaneous absorption of boron as boric acid, borax, and disodium octaborate tetrahydrate in humans. Biological Trace Element Research. 1998;66(1-3):131-145.
• Naghii MR, Wall PM, Samuelson MI. The boron content of selected foods and the estimation of its daily intake among free-living subjects. Journal of the American College of Nutrition. 1996;15(6):614-619.

These five elements work together across all biological pathways affected by systemic stress. You do not need to understand the mechanisms to benefit. Start here.